REMARKS

A. Office Action Summary.

In the Office Action mailed March 31, 2003, claims 1 and 4 stand rejected under 35 U.S.C. § 103(a) over the applicant's admitted prior art (AAPA) in view of *Miyazawa et al* (U.S. Patent No. 5,953,619) and *Evans et al* (U.S. Patent No. 6,150,184).

Claims 2-3 and 5-11 stand rejected under 35 U.S.C. § 103(a) over the AAPA in view of *Miyazawa* and *Evans*, and further in view of *Joshi et al* (U.S. Patent No. 6,322,849) and *Van Buskirk et al* (U.S. Patent No. 6,316,797).

Claims 12-17 and 19-24 stand rejected under 35 U.S.C. § 103(a) over the AAPA in view of *Miyazawa* and *Otto et al* (U.S. Patent No. 6,284,712).

Claims 27-31 stand rejected under 35 U.S.C. § 103(a) over the AAPA in view of *Miyazawa* and *Van Buskirk*.

The rejections of claims 1-17, 19-24, and 27-31 as set forth above are respectfully traversed and addressed below.

B. Distinguishing Features of Independent Claims 1, 12, 27 and 30 Over *Miyazawa* and *Evans*.

Independent claims 1, 12, 27, and 30 all contain, in pertinent part, two important limitations:

(1) The capacitor dielectric layer is annealed to form perovskite phases before the top electrode layer is deposited; and

(2) The capacitor, including the top electrode, is again annealed to form columnar grains.

The assertion in the Office Action that *Miyazawa* contains sufficient support for both of these limitations as claimed is respectfully traversed.

Miyazawa appears to teach only a single PZT anneal that can be performed either before or after the formation of the top electrode, and that the functions of perovskite phase formation and columnar grain growth are merged in this single anneal. Although *Miyazawa* does mention PZT crystallization anneal before or after top electrode formation, it fails to teach that the PZT layer needs to be crystallized into the required perovskite phase

by an RTA anneal before performing a PZT anneal after top electrode formation. Rather, *Miyazawa* teaches the annealing of as-deposited PZT (amorphous) before or after top electrode formation. In fact, annealing as-deposited PZT with an accompanying top electrode layer often causes de-lamination of the top electrode because of the great stress due to the shrinkage of PZT during crystallization. This problem was recognized by the inventors, and that is why in the present invention as claimed, the PZT layer is crystallized into the perovskite phase before depositing the top electrode layer.

PZT grain growth also needs a rich Pb environment. A properly grown PZT grain structure can dramatically improve the ferroelectric performance of the capacitor, as was also recognized by the inventors. A second step anneal is therefore performed to form proper PZT grain structure. Since the PZT is already crystallized, as claimed, the second step anneal (i.e. the co-anneal) does not cause peeling of the top electrode because the shrinkage during this anneal is much smaller. The PZT-top electrode co-anneal process also helps to reduce the Pb depleting layer between the PZT and top electrode layers.

The Examiner asserts that *Miyazawa* discloses a first PZT anneal to form a perovskite phase and a second PZT anneal to change the ferroelectric material into a form having grains with a columnar structure. The purported "first anneal" is from the background section of the patent, and the purported "second anneal" is from the detailed description section of *Miyazawa*.

However, a closer reading of *Miyazawa* makes it clear the cited "first" and "second" PZT anneals indicates that they are the exact same anneal. In fact, there is only one PZT anneal taught in *Miyazawa*, which does not teach that PZT thin films need to be crystallized using RTA anneal before the second step grain growth anneal with the accompanying top electrode layer as claimed.

Applicants also respectfully traverse the Examiner's assertion that *Miyazawa* teaches forming a columnar structure as claimed. *Miyazawa* does not mention PZT columnar structure or PZT grain growth. *Miyazawa* only mentions the polycrystallization of the PZT film.

A single PZT anneal without a top electrode as taught in *Miyazawa* is a common approach for forming PZT thin film capacitors, but the ferroelectric performance is not optimum because of the Pb depleting layer in PZT-electrode interfaces due to large Pb loss during PZT anneal, as was recognized by the inventors. The claimed method of the present invention—involving the establishment of PZT grain growth with the top electrode layer on top of the dielectric layer after PZT crystallization—can effectively reduce the Pb loss during PZT grain growth, giving rise to greatly improved ferroelectric performance.

Although *Miyazawa* does mention a recovery anneal, post capacitor patterning, which is the same as taught by *Evans,* this anneal is solely to recover the etch damage and has nothing to do with forming the PZT columnar grain structure as claimed. This anneal is usually performed at temperatures lower than PZT annealing temperatures. Accordingly, this second anneal taught by *Miyazawa* is not a claimed PZT anneal.

The second anneal as taught in *Evans*, like that in the AAPA, was performed on PZT thin film capacitors with an etched top electrode. The purpose of this anneal is to recover the existing ferroelectric performance from the damage to the PZT thin film during top electrode etching and has no effect of further improving the ferroelectric performance of the PZT thin film capacitor. The second step anneal as claimed improves ferroelectric performance by forming a columnar grain structure as well as a smoother PZT-top electrode interface and eliminates the Pb deficient surface layer as previously discussed.

Independent claims 1, 12, 27, and 30 are thus patentable over *Miyazawa, Evans* and AAPA.

C. *Otto* is Non-Analogous Art and Fails To Teach Or Suggest Perovskite Phase Prior To The Top Electrode Formation and Columnar Grains After Top Electrode Formation As Claimed.

To qualify as analogous prior art, a reference "must either be in the field of applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the inventor was concerned." *In re Oetiker*, 977

F.2d 1443, 1446 (Fed. Cir. 1992). "A reference is reasonably pertinent if, even though it may be in a different field from that of the inventor's filed of endeavor, is one which, because of the matter with which it deals, logically would have commended itself to an inventor's attention in considering his problem." *In re Clay*, 966 F.2d 656, 659 (Fed. Cir. 1992).

The field of endeavor of the present case relates to

> . . . . ferroelectric memory integrated circuit processing. In particular, the invention relates to deposition and annealing process steps for forming the dielectric and electrode layers of ferroelectric capacitors in ferroelectrc memory integrated circuits. Specification, page 1, lines 2-7.

The problem with which the inventors were concerned was "improvement in PZT quality and process complexity". Specification, page 4, lines 15-16.

In contrast, the field of invention of *Otto* is "high-performance oxide superconductors", clearly <u>not</u> within the applicants' field of endeavor.

Thus the question becomes, what is the problem with which *Otto* is concerned and is it reasonably pertinent to an increase in PZT quality and process complexity?

The problem with which *Otto* is concerned is the following:

> The present invention further relates to a method for healing defects introduced into the oxide superconductor phase during processing, thereby improving superconducting properties. The present invention also relates to the processing of high performance bismuth-strontium-calcium-copper oxide superconductors and oxide superconductor composites and a method for improving the critical transition temperature (T_c) and critical current density (J_c) of these oxide superconductors.

Otto at col. 1, lines 13-23. The problems of interest to *Otto*—healing defects, improving Tc and Jc in bismuth-strontium-calcium-copper oxide superconductors—are not problems reasonably pertinent to PZT (lead zirconium titanate) or SBT (strontium bismuth tantalate) ferroelectric memory. Accordingly, *Otto* constitutes non-analogous art relative to the present application, and cannot be used to support a *prima facie* obviousness rejection. For this reason alone, withdrawal of the rejection based on *Otto* is proper and respectfully requested.

In addition, however, *Otto* is cited for the proposition that a first and second anneal is performed in an environment comprising a mixture of oxygen and inert gas. However, *Otto* is silent regarding the formation of perovskite phases, and the features described above which are distinguishing over *Miyazawa, Evans* and AAPA. Thus, *Otto* fails to provide the basis for rejection for which *Miyazawa, Evans* and AAPA are deficient, so that independent claims 1, 12, 27 and 30 are patentably distinguishable over the

D. *Van Buskirk* Fails To Teach Or Suggest Perovskite Phase Prior To The Top Electrode Formation and Columnar Grains After Top Electrode Formation As Claimed.

Van Buskirk is cited for an iridium oxide top electrode. However, *Van Buskirk* is silent regarding the formation of a perovskite phase as claimed prior to the top electrode formation and the other features described above which are distinguishing over *Miyazawa, Evans* and AAPA. For the reasons given above, claims 1, 12, 27 and 30 are patentably distinguishable over the combination of *Miyazawa, Evans,* AAPA, *Otto* and *Van Buskirk.*

E. *Joshi et al* Fails To Teach Or Suggest Perovskite Phase Prior To The Top Electrode Formation and Columnar Grains After Top Electrode Formation As Claimed.

Joshi is cited for a palladium and platinum bottom electrode. However, *Joshi* is silent regarding the formation of a perovskite phase as claimed prior to the top electrode formation and the other features described above which are distinguishing over *Miyazawa, Evans* and AAPA. For the reasons given above, claims 1, 12, 27 and 30 are patentably distinguishable over the combination of *Miyazawa, Evans,* AAPA, *Otto* and *Van Buskirk.*

F. Dependent claims 2-11, 13-17, 19-24, 28, 29 and 31 Are Allowable as Depending from a Patentably Distinguishable Base Claim

Dependent claims 2-11, 13-17, 19-24, 28, 29 and 31 all depend directly or indirectly from one of the independent claims 1, 12, 27 and 30 which, as discussed above, are patentably distinguishable over the references of record. Accordingly, each of these dependent claims is allowable as depending from an allowable base claim.

G. Petition for 1-Month Extension.

Applicant hereby petitions for a 1-month extension, extending the due date for response from June 30, 2003 to July 31, 2003. The $110 fee required is enclosed herewith. Please charge any other fee associated with this filing to Deposit Account No. 50-1123.

H. Information Disclosure Statement.

Please consider the references listed in the Information Disclosure Statement filed herewith. The required $180 fee is enclosed herewith. Please charge any other fee associated with this filing to Deposit Account No. 50-1123.

I. Conclusion.

For the reasons give above, pending claims 1-17, 19-24, and 27-31 are believed to be fully allowable over the combination of cited references, and the case is in condition for allowance. Should any issues remain, the Examiner is kindly asked to the telephone the undersigned.

Respectfully submitted,

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